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Solar Water Heating Basics for Homeowners

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What is Solar Water Heating?

- Solar Assist or Solar Pre-heat
- Always keep the existing heater as backup to solar
- Great way to conserve energy, reduce your utility bill, increase the value of your home, and reduce your carbon footprint!

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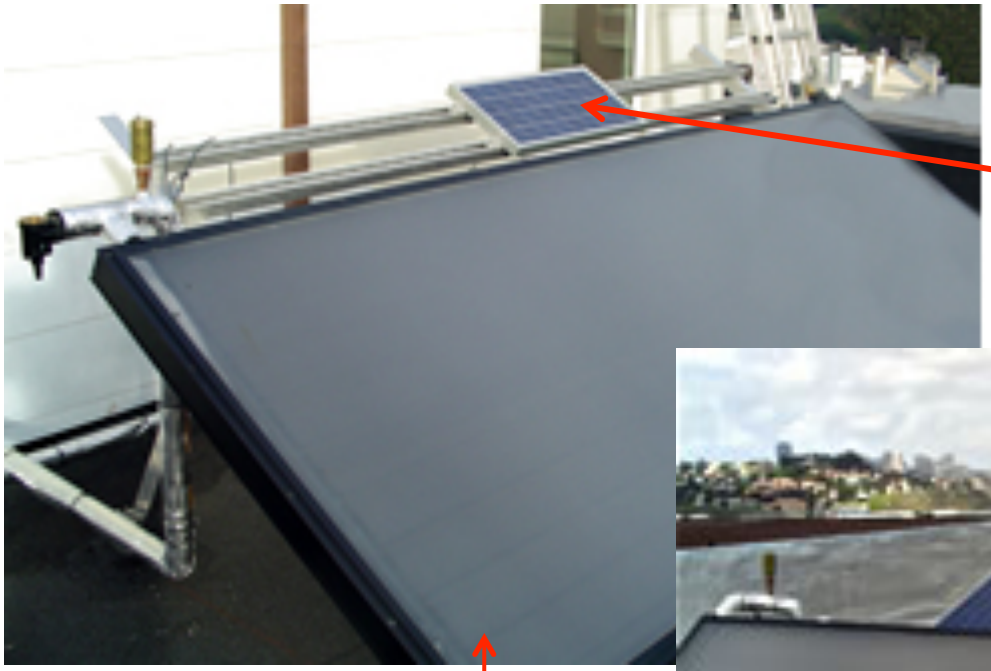


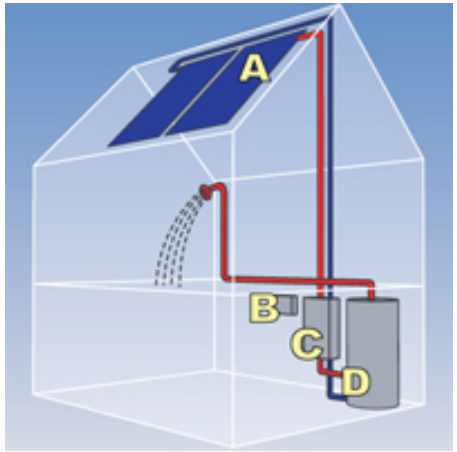
Solar Electric (PV) Panels

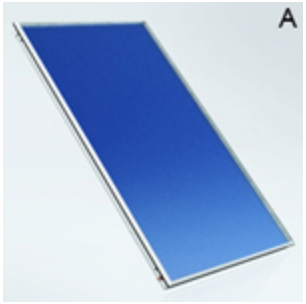
Solar Thermal Collectors

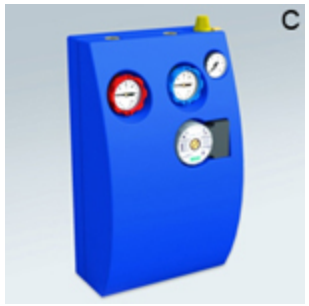
Source: Occidental Power

Basic Components

- a) Solar Collector
- b) Sensors, Controller
- c) Pump (Active Systems)
- d) Solar Storage Tank







Source: Schuco

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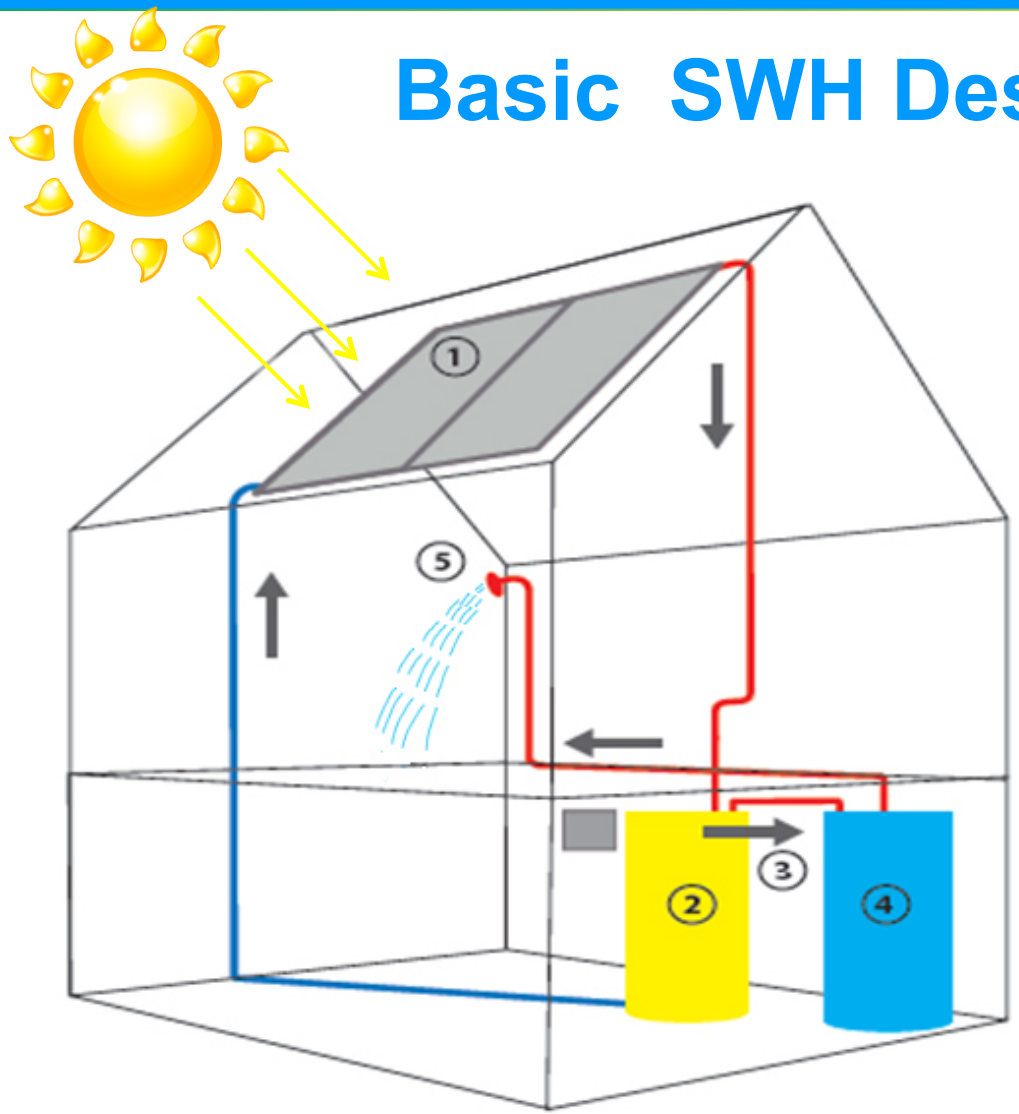
Basic SWH Design- Step 1



1. Sun heats water or a heat transfer fluid in a solar collector on the roof

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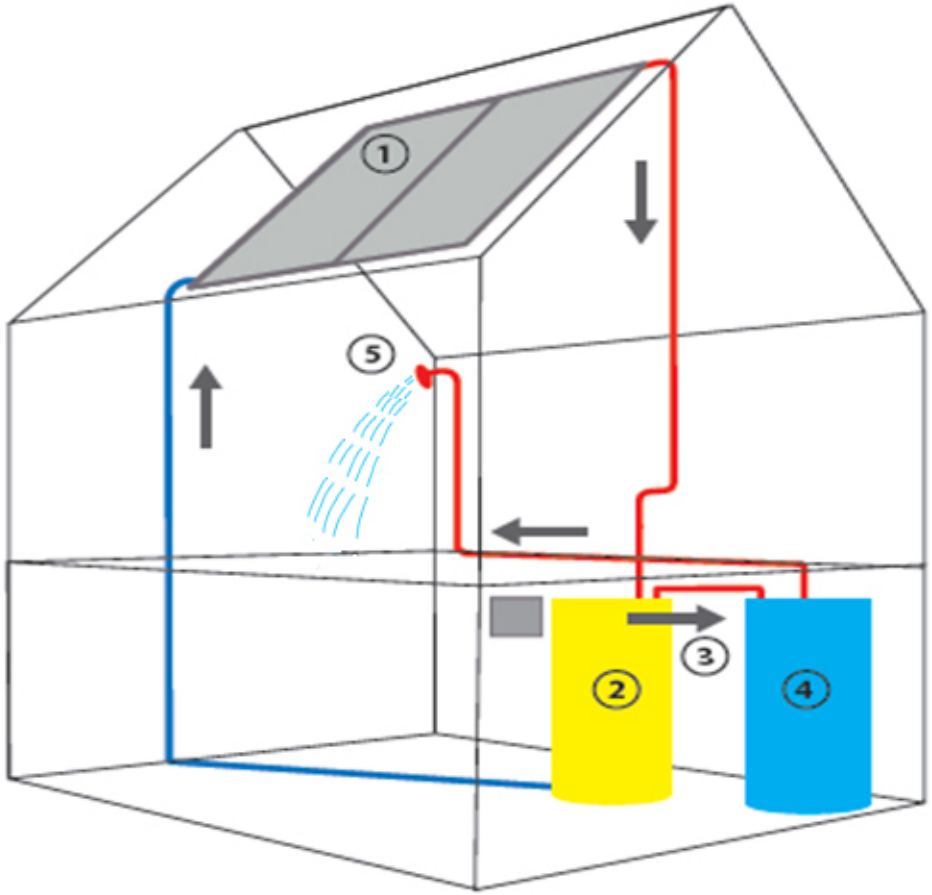
Basic SWH Design- Step 2



2. Solar heated water is pumped into a storage tank

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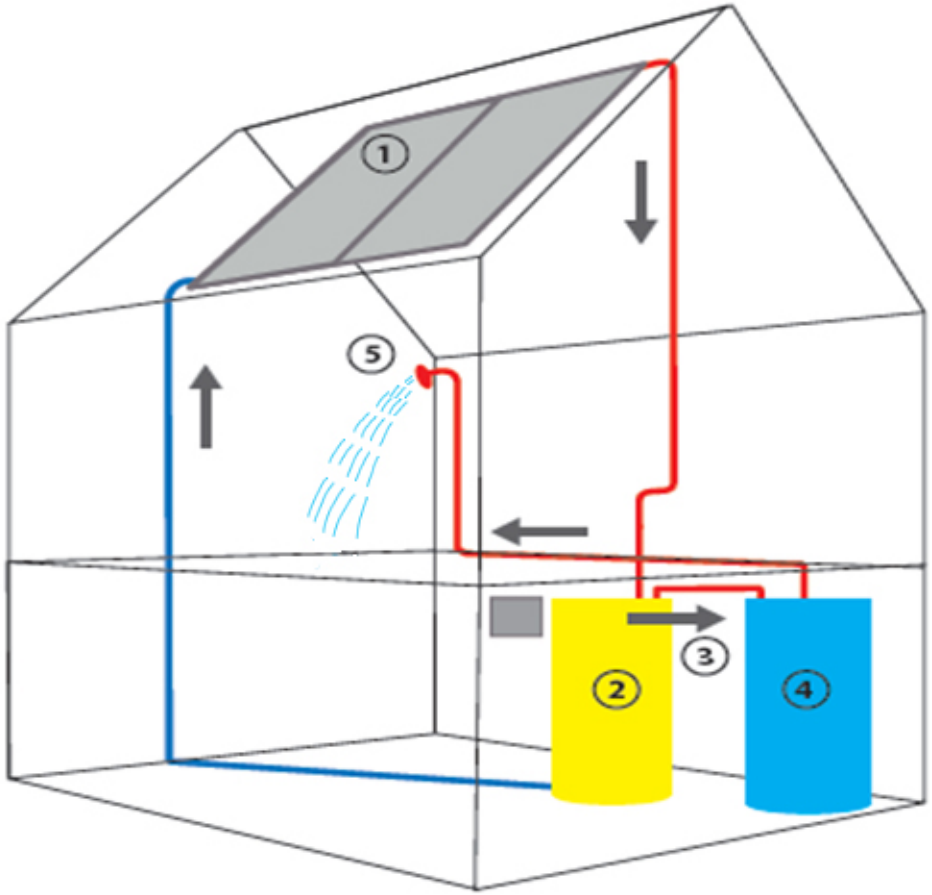
Basic SWH Design- Step 3



3. Your conventional water heater draws the hot water out of the solar storage tank when there is a demand for hot water

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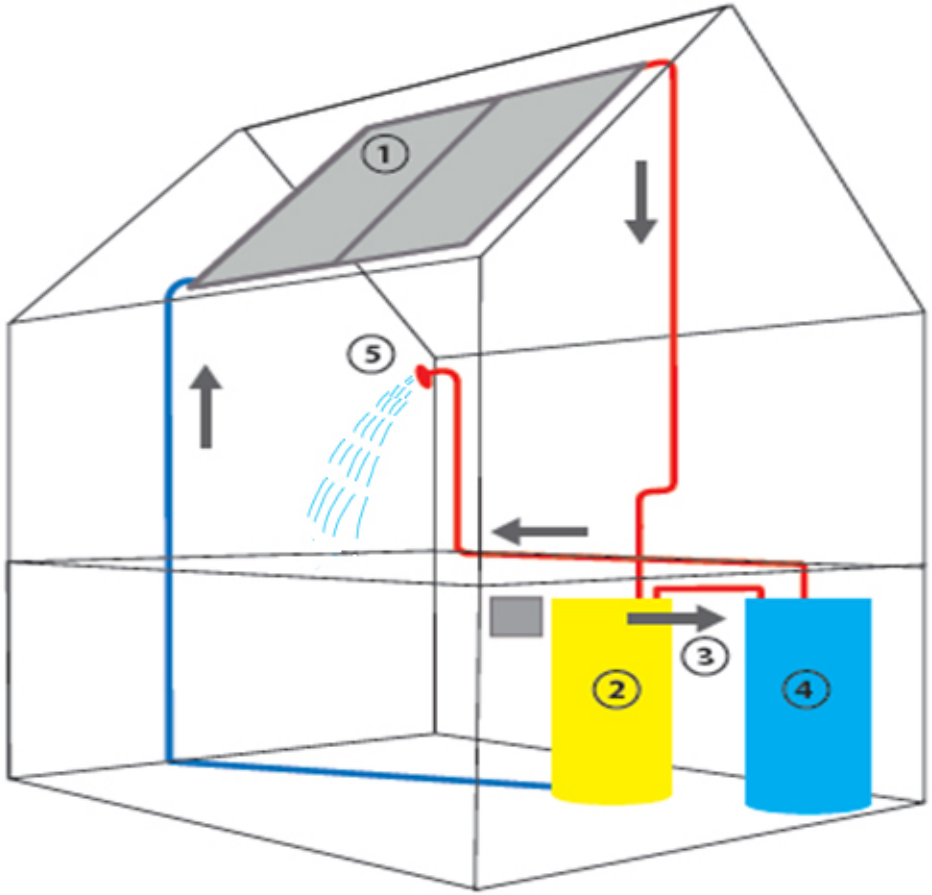
Basic SWH Design- Step 4



4. If needed, the conventional water heater may boost the temperature of the solar heated water before sending it through the home

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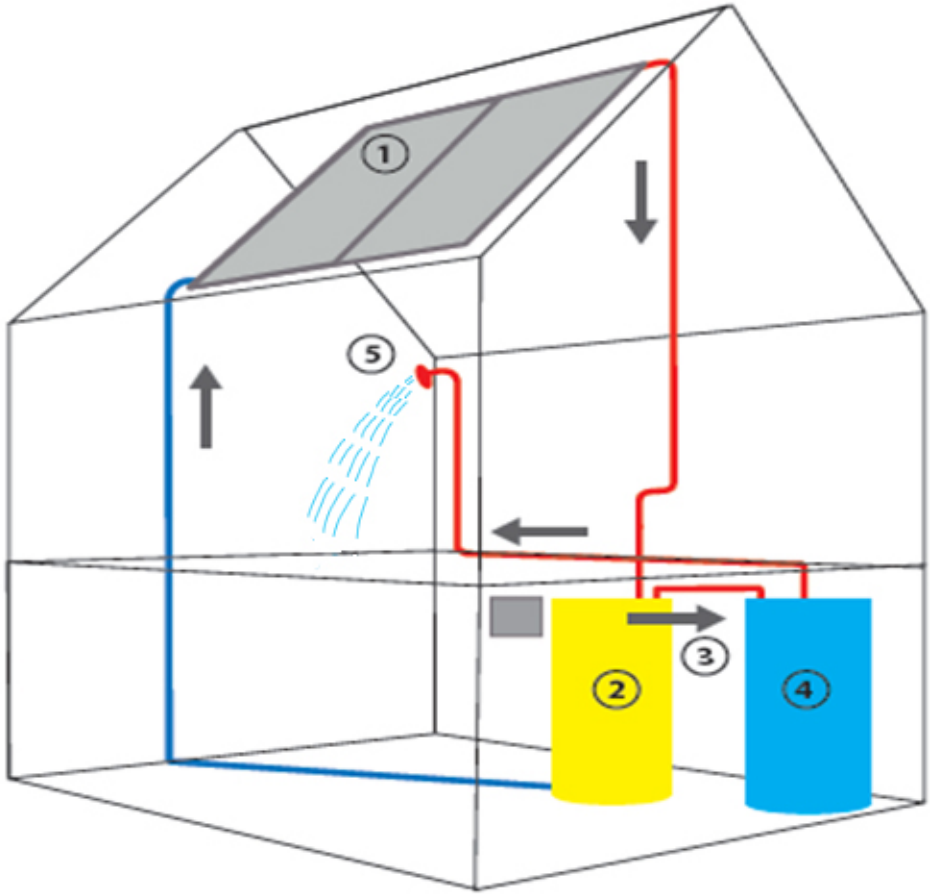
Basic SWH Design- Result



5. Using the sun to heat your water reduces the energy needed to heat your water

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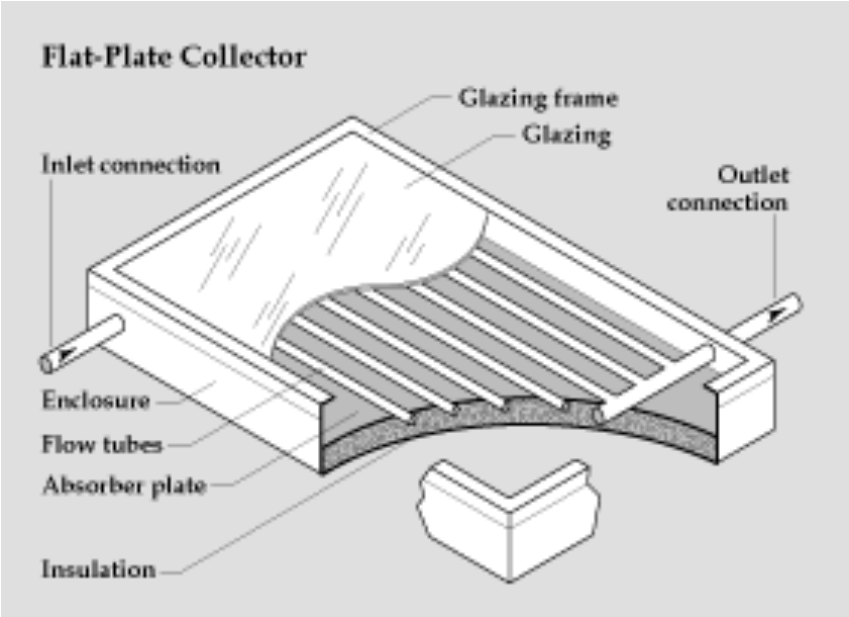
Solar Water Heating Systems

- Collector Types
- System Types
  - Pros and Cons
  - Freeze Protection
  - Overheat Protection

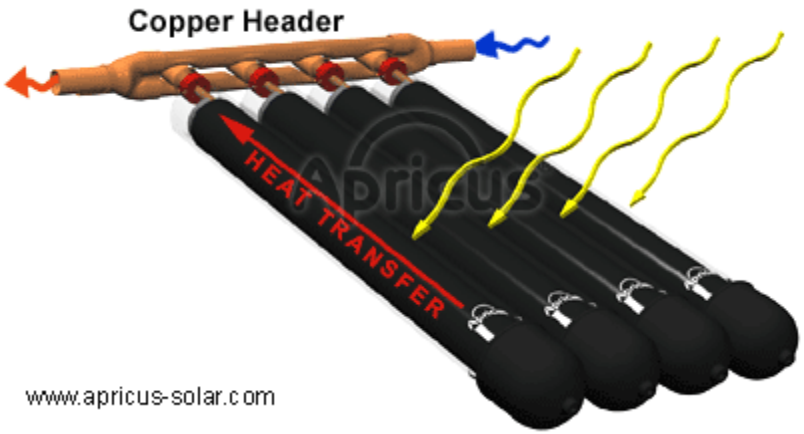
Glazed Flat-Plate Collector



Source: EERE

Butler Sun Solutions

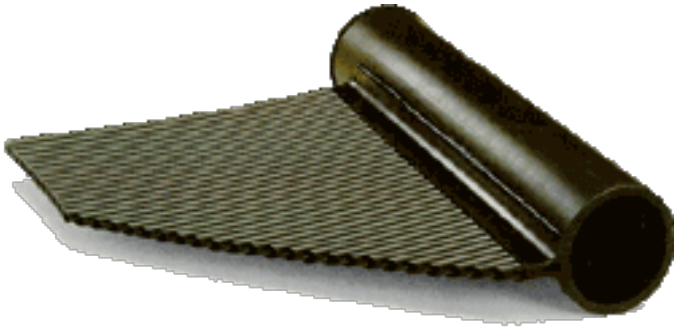
Evacuated Tube Collector



Source: Apricus

CleanTech

Unglazed Collector



Source: FAFCO

Son Energy

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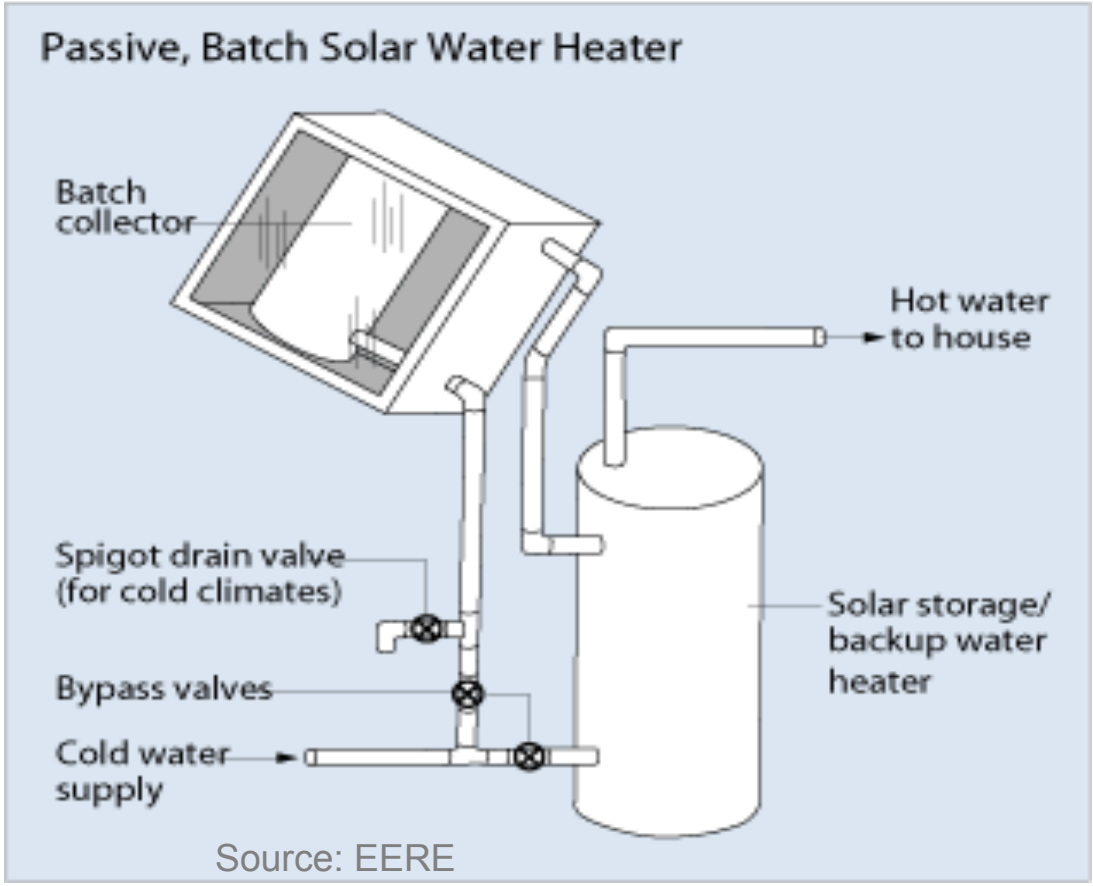
Two Types of Basic SWH Systems

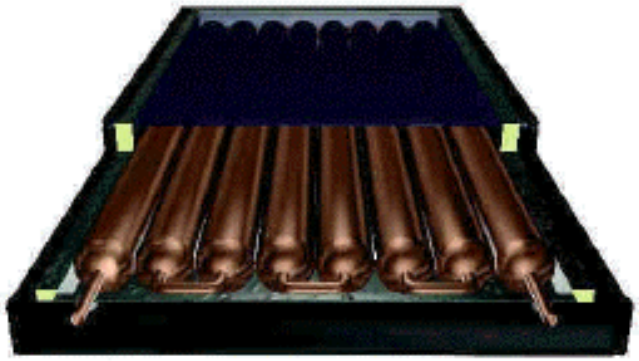
1. **Passive** – no pumps
   - Integral Storage Collector (ICS)
   - Thermosyphon
2. **Active** – uses pumps to move the water through the collector
   - Direct Forced Circulation
   - Closed Loop Glycol
   - Closed Loop Drainback

Passive System: Integral Collector Storage (ICS)



- **Passive System (no pumps)**
- **Open loop**

ICS System



Source: SunEarth

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Good Application for ICS Systems

- Good for those who use hot water at night, rather than first thing in the morning
- Inefficient in cold climates, due to heat losses at night
- warmer climates are the best location for ICS system

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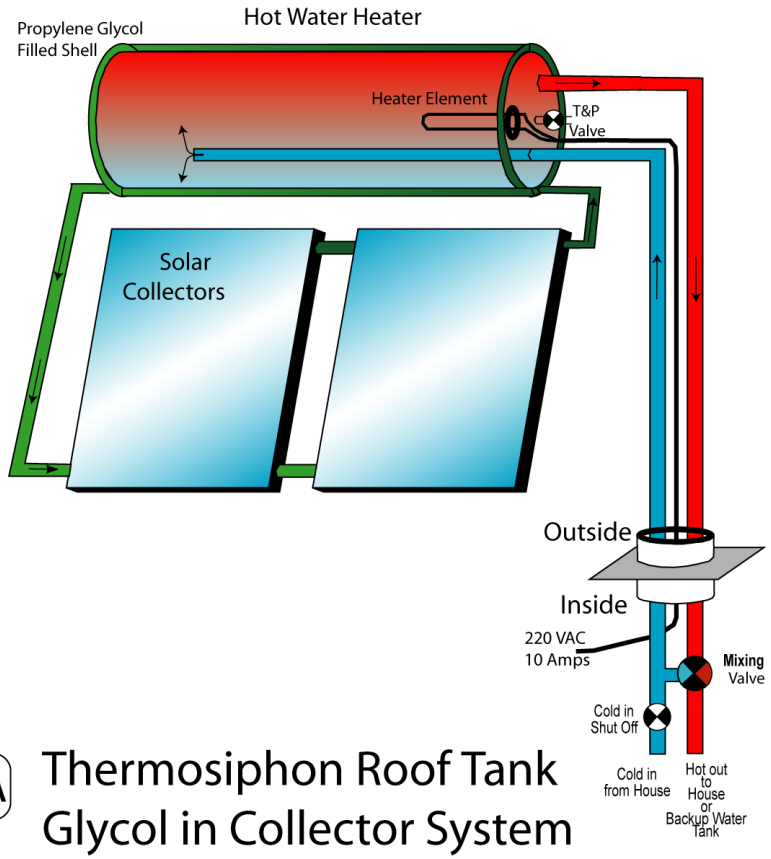
Passive System - Thermosyphon



3A Thermosiphon Roof Tank
Glycol in Collector System

Closed loop with heat exchanger & antifreeze

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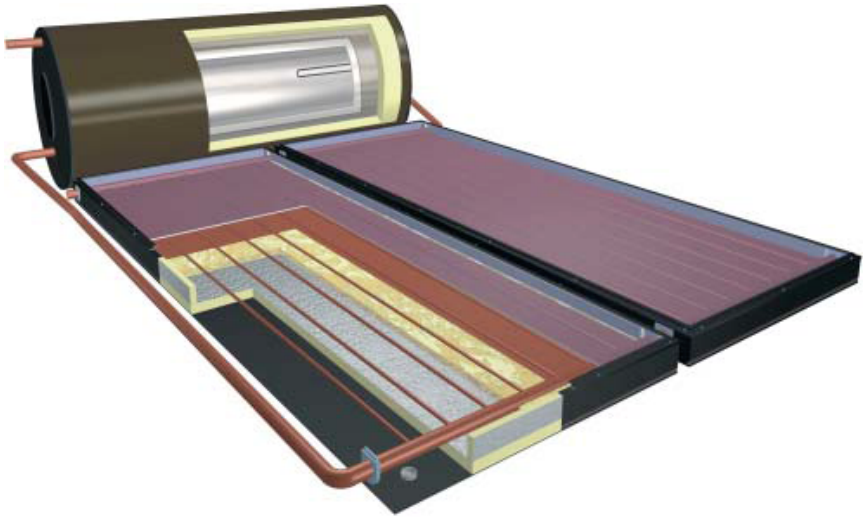
Thermosyphon Collector



Source: SunEarth

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Thermosyphon-Pros and Cons

Advantages:

- Simple- No moving parts (Passive)
- Good for colder climates

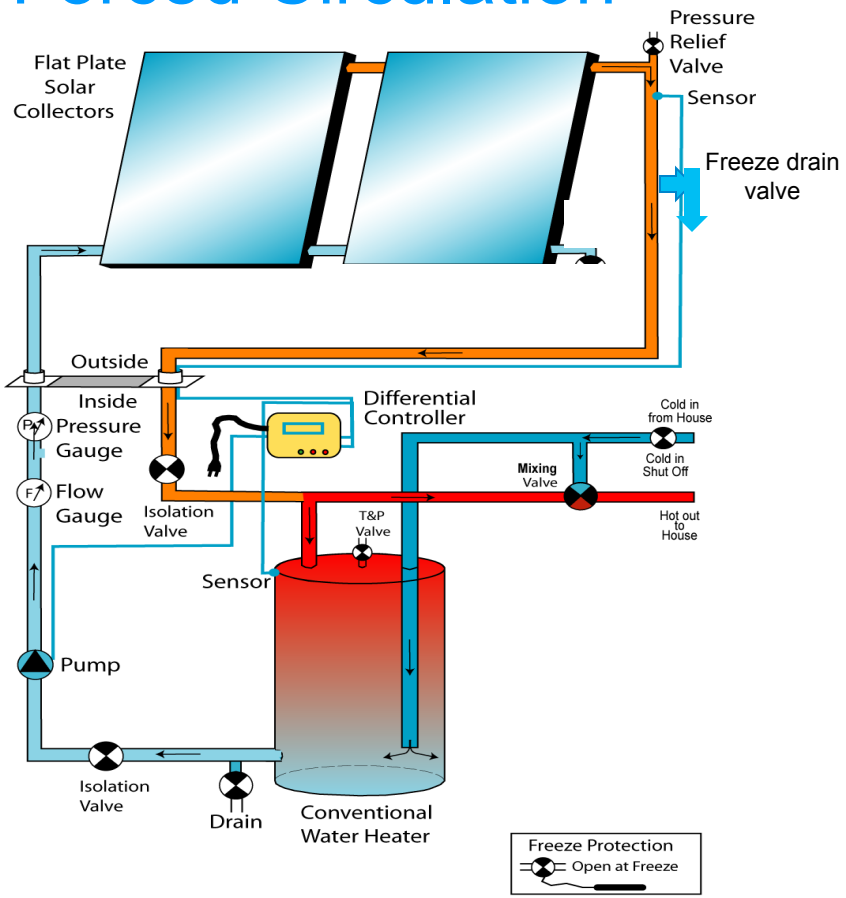
Disadvantages:

- Higher roof load
- Glycol and heat exchanger reduce efficiency

Active System – Direct Forced Circulation

- Open loop
- Only in climates where freezing is a rare occasion

DFC systems not eligible!



Direct Forced Circulation
Open Loop

Source: FSEC

Direct Forced Circulation- Pros and Cons

Advantages:

- Simple-fewer components
- Good for climates with warmer temperatures

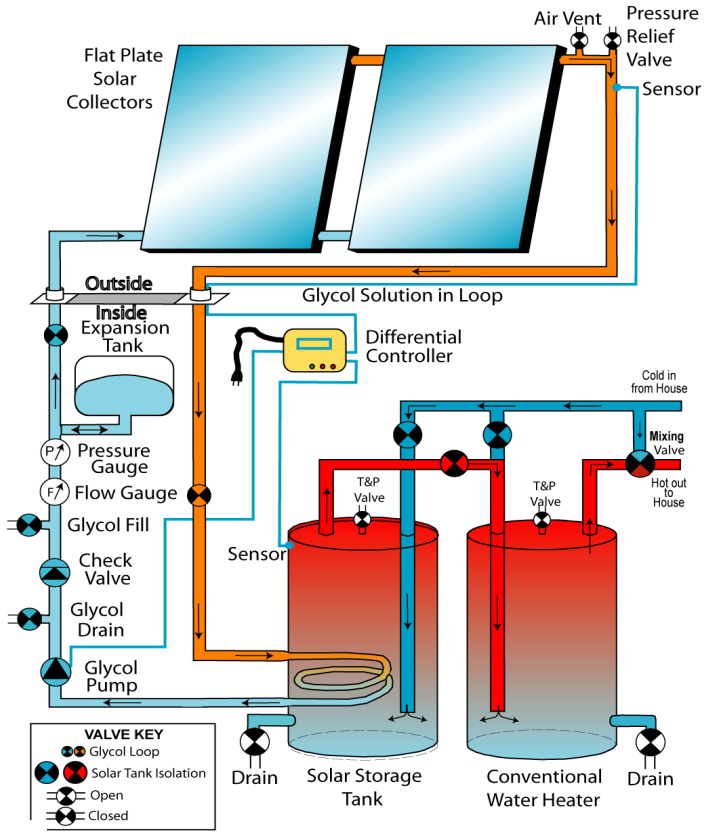
DFC systems not eligible!

Disadvantages:

- Freeze protection is limited to infrequent & light freezes
- Inappropriate for use with hard water- high scaling potential

Active System – Closed Loop Glycol

- Glycol = Anti-freeze
- Cold Climates



Closed Loop High Pressure, Built In Heat Exchanger

Source: EERE

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Closed Loop Glycol- Pros and Cons

Advantages:

- Basic principles well understood by conventional plumbing trades
- No problems with hard water
- Can be powered by PV

Disadvantages:

- Heat exchanger & antifreeze reduce efficiency
- Fluid may break down at high temperatures

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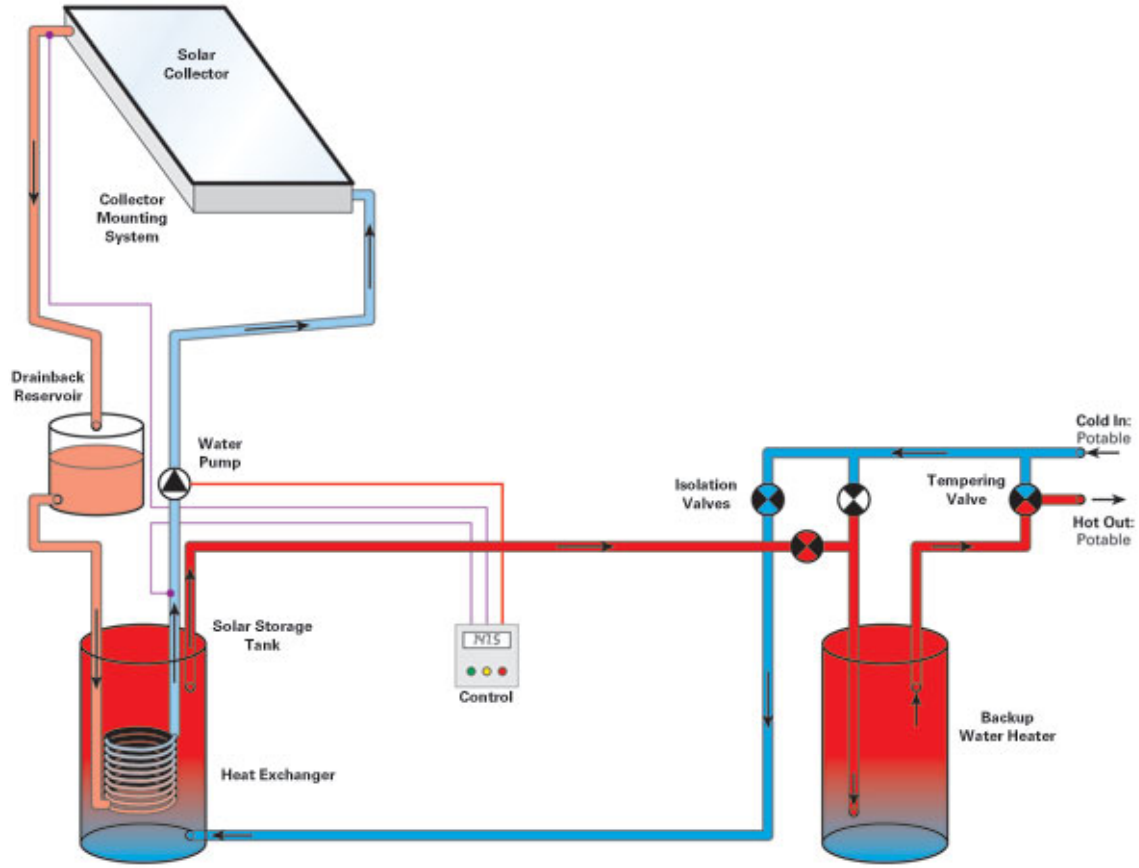
Active System – Closed Loop Drain back



- **Cold and Hot climates**

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Drain back Pros and Cons

Advantages:

- No problems with hard water
- Reliable freeze and overheat protection systems
- No glycol

Disadvantages:

- Heat exchanger reduces efficiency
- Collectors & piping must have adequate slope to drain
- Requires larger pump to lift water on startup

Source: SunTrek Solar

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NEW CSI-Thermal Program

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2007-2009 Project Cost Data for Single Family SWH

Type of System	Integral Storage Collector	Direct Forced Circulation	Thermo-syphon	Closed Loop Glycol	Closed Loop Drain back	Overall Average
Number Installed	12	34	74	125	61	Total= 306
Average Cost	$5,529	$6,207	$6,680	$6,989	$6,868	$6,746
Average Incentive	$924	$1,408	$1,180	$1,325	$1,211	$1,260

As of April 2010

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CSI-Thermal Program Background

- **$350M Incentive Program (2010-2018)**
  - **Senate Bill (SB) 1, 2006**: Authorized $100.8M of incentives for solar thermal technologies that displaced electricity usage
  - **Assembly Bill (AB) 1470, 2007**: Authorized $250M for the installation of 200,000 SWH systems that displace natural gas

- **SWH Pilot Program** created to test market from July 2007- Dec 2009

- **CSI-Thermal Program** approved by CPUC in January 2010

CSI-Thermal Implementation Timeline

- May 1, 2010: Started accepting residential applications
- October, 2010: Start accepting multi-family/commercial applications
- Any project installed or received a building permit after July 15, 2009 may apply

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CSI-Thermal: Customer Eligibility

- Gas water heating customers of PG&E, SDG&E, or SoCal Gas- Retrofit and new construction
- Electric water heating customers of PG&E, SDG&E, or SoCal Edison- Retrofit projects only
- Propane users are NOT eligible, even if they are electric customers of the above utilities

CSI-Thermal: Technology Eligibility

Eligible:

- Domestic Solar Water Heating Systems

Not Eligible:

- Pools and Spas

May be added to the program at a later date:

- Non-DWH gas displacing solar thermal technology (space heating and cooling)

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Incentives

- Calculated based on expected performance, using expected annual energy savings (SRCC rating), surface orientation factor, and shading analysis
- 4 step declining incentive structure
- Different incentive amounts for natural gas vs. electric displacing systems

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Incentives: Natural Gas

Steps	$ per therm saved	Single Family Cap
Step 1	$12.82	$1, 875
Step 2	$10.26	$1,500
Step 3	$7.69	$1,125
Step 4	$4.70	$688

Example: OG-300 Incentive Formula (Natural Gas)

1. Annual Energy Savings =120 therms
2. Step 1= $12.82/per therm saved
3. Surface Orientation Factor= 1.0
4. Shade Factor= 98% solar availability

Calculation:

125 therms x $12.82 x 1.0 X .98 **= $1508**

Natural Gas
Water Heating Costs

- Average home with a natural gas water heater uses 200 therms per year for water heating
- SDG&E charges roughly $1.25/therm
- 200 x $1.25 = $250/year for water heating

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SWH Savings with a Natural Gas Water Heater

- Average SWH system in San Diego installed with a natural gas water heater saves 120 therms/year
- 120 x $1.25 = $150/year **saved** on water heating
- Annual water heating bill is reduced from $250 down to $100! ($250-$150=$100)

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Incentives: Electric

Steps	$ per kWh saved	Single Family Cap
Step 1	$0.37	$1262
Step 2	$0.30	$1025
Step 3	$0.22	$750
Step 4	$0.14	$475

Example: OG-300 Incentive Formula (Electric)

1. Annual Energy Savings =2780 kWh
2. Step 1= $0.37/per kWh saved
3. Surface Orientation Factor= 1.0
4. Shade Factor= 98% solar availability

Calculation:

2780 kWh x $0.37 x 1.0 X .98 **= $1008**

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Electric Water Heating Costs

- Average home with electric water heater uses 4,000 kWh per year for water heating
- SDG&E charges roughly $0.20/kWh
- 4,000 x $0.20= $800/year for water heating

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SWH Savings with an Electric Water Heater

- Average SWH system in San Diego installed with an electric water heater saves 2,800 kWhs/year
- 2,800 x $0.20 = $560/year **saved** on water heating
- Annual water heating bill is reduced from $800 down to $240! ($800-$560=$240)

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Additional Incentives

- Federal Tax Credit – 30% of cost (post-incentive)
- Increased property value but exempt from increase property tax
- Protection against future rate increases

SWH Financials

Average Cost
- Based on 3-4 person household

→ **Average Cost**
- $6700

CSI – Thermal Incentive
- $12.82/therm (average therms saved/year =125)

→ **Average rebate** (natural gas system)
- $1500

Federal Tax Credit
- 30% of out of pocket costs

→ $5200 x 30% = $1560

Net Investment: $3640

Environmental Economics of SWH

- NG offset – Lbs. CO_2 Saved 38,089
- Electric offset – Lbs. CO_2 Saved 26,992
- Equivalents
  - 2004 Toyota Corolla driven 12,000 miles/yr
    - 8,095 lbs. CO_2/year
    - NG offset = no driving for 4.7 years
    - Electric offset = no driving for 3.3 years
  - Trees
    - Absorb 2,000 lbs. CO_2/year
    - NG offset = planting 19 trees
    - Electric offset = planting over 13 trees

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What to expect from program participation

Quality Control:

- Contractors must come to a one day training to participate
- Projects must be permitted (contractor will obtain)
- Projects may be inspected by us
- Projects may be selected for performance metering

Customer Service:

- Call us anytime with questions
- Unbiased, objective support

How to select a SWH Contractor

- Select from the eligible contractor's list: http://www.gosolarcalifornia.org/solarwater
- Ask about the contract structure- who gets the rebate?
- Get at least 3 bids

Contract Structure Options

Scenario: Total cost=$6,700; Incentive=$1,500

Option 1: You pay $5,200 to contractor; $1,500 incentive goes to contractor after project completion

Option 2: You pay $6,700 to contractor; $1,500 incentive goes to you after project completion

California Energy Commission (CEC)
Cash for Appliances Program

- Single family homes only: $750 flat rebate
- SWH system must be Energy Star
- Must replace & recycle an old water heater

www.energy.ca.gov/recovery/energystar.html